A NEW MOSQUITO CAGE.

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THE mosquito problem is becoming an important one throughout practically all of the western hemisphere, as well as in large areas of Europe, Asia, Africa, and Australia. I do not refer alone to that portion of North America lying between the thirtieth parallels of north and south latitudes. In these regions the normal habitat of the *Stegomyia fasciata*, endemic and epidemic foci of yellow fever make the problem not only important, but urgent; in fact, a large part of the energies of sanitary administrations in Cuba, Mexico, and the Gulf states of the United States, must be directed toward the destruction of mosquitoes and the prevention of their breeding. There are evidences, however, that this problem, now mainly the problem of the hygienist of the Stegomyia area, must be met also by the hygienists of all areas where diptera normally or occasionally occur. Mosquitoes are now entering public hygiene in the United States, not alone in the relatively insignificant "malaria area," in the rôle of "unsanitary nuisances."

Although all varieties of the common Culex and Anopheles have been proven to convey disease, the people of Northern American latitudes are more directly interested in the problem from the standpoint of public comfort. In certain areas, notably on the Atlantic coast of New Jersey and New York, the mosquito is an important economic problem, and its extermination in these states has repaid many fold the expenditure of public money through increased value of the land. The extermination of mosquitoes over any large area, or upon any extensive scale, requires careful study and a definite plan of campaign. An absolutely essential preliminary, is a geographical survey of the area involved, to determine the varieties of mosquitoes to be dealt with, and their distribution. In fact the sanitary laboratory in the near future will have to make studies of variety and distribution of mosquitoes with the same care and attention as is now given to pathogenic organisms. For this purpose it is necessary to collect,

raise, and observe mosquitoes in the laboratory. The study of mosquitoes includes the collection of eggs or larvae, hatching in water, and the preservation and observation of the imagines in suitable cages. The cage here described was devised with the object of facilitating the raising of mosquitoes and their observation during hatching, and in the imago stage. As a preliminary to experiment, observation, and diagnosis of variety, eggs or larvae must be collected, and transferred to hatching-jars. The larvae may be collected by means of a fine net passed through any pond which may breed mosquitoes, well below the surface of the water. Eggs may be easily recognized by a careful observer, and transferred by means of a spoon. The eggs or larvae are transferred to a hatching-jar filled with rainwater until they have fully developed.

The usual method of developing imagines is to hatch the eggs or larvae in jars protected with netting, and to transfer each adult insect separately by means of a short test-tube to cages of wire netting. In order to avoid the laborious handling of each single insect, to avoid loss during transfer, and to facilitate observation and experiment, the larvae jars have been combined with the imago cage in the manner illustrated in the drawing.

Description of the cage.—The cage is of wood, divided into three compartments by partitions. The base is made of a single piece of wood and supports the two vertical wooden partitions and two end pieces. A floor separates the larvae jars from the imago compartments. The top of each imago compartment is closed by a piece of plate glass, held lightly by screws. The sides of the imago portion of the cage are closed by wire and cloth netting (a double layer) held in place by brass upholstery tacks.

The two vertical partitions divide the space between the base and floor into three compartments, each made to fit accurately one of the larvae jars, so that the latter can be slid easily in and out of their compartments without allowing any interval through which the insects can escape when the jar is in place. Each larvae jar communicates with its imago compartment by an opening slightly smaller than the mouth of the jar. Through this opening the imagines pass upward into the netting cage as soon as they undergo their metamorphosis.

The partitions and ends of the cage are supported above by two longitudinal wooden strips each $1\frac{1}{2}''$ wide, mortised into the partitions and ends. All of the wood used in the construction of the cage is $\frac{1}{2}''$ pine.

As it is important for the larvae jars to fit accurately, the wood should be well seasoned and given a thorough rubbing with an oil filler.

The cage, including the netting, should be painted inside and out with a white enamel paint, which will add materially in observing the mosquitoes.

The plates inclosing the tops of each compartment are a good quality of plate glass, $\frac{1}{8}''$ thick, and bored for from three to six $0.2''$ screws.

The two end plates are $9\frac{11}{16}''$ by $8\frac{3}{16}''$. The plate closing the central compartment is $9\frac{4}{16}''$ by $8\frac{3}{16}''$, and the feeding plate of the same dimensions.

The full size of the cage is, height 18 inches, width 8 inches, length 28 inches. The larvae jars are $2\frac{1}{2}''$ high, and the diameter of their mouths $4\frac{1}{2}''$. Their compartments correspond in height, but are somewhat larger in the other dimensions. A space is thus allowed on the floor of the imago compartment upon which the mosquitoes can rest, and upon which their food (dates, bananas, sugar, and water, etc.) is placed in small butter plates.

Feeding-plate.—If it is desired to propagate mosquitoes through several generations, or to persuade fecund females to lay, or to carry

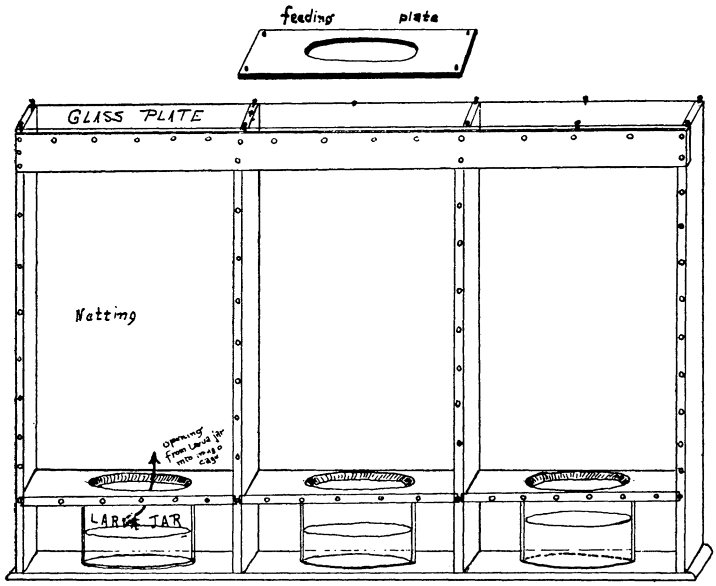

FIG. 1.

out any line of experiments in diseases for which the mosquito is the intermediate host, provision must be made to furnish the impregnated female insects with blood. This is absolutely essential in the case of the Stegomyia, as the female will not lay fertile eggs (if at all) without the previous ingestion of blood, preferably from a human source.

The usual method of furnishing blood to insects in cages, is to provide a special sleeve of netting, protected with a draw-string through which the arm can be introduced into the cage. There are two serious objections to this method. One is that the string produces folds in the netting into which mosquitoes will frequently squeeze themselves

and die, and the other is the impossibility of observing the insects during the act of sucking blood. In the present cage the netting sleeve is replaced by a feeding-plate. This plate is of glass with a central elliptical opening made to fit the forearm of the experimenter at its largest part. A paper or cardboard pattern should be made for the feeding-plate and for the three plates closing the top of the compartments, to show their size, the position of the screw holes, and the position of the central opening in the feeding-plate.

To make the pattern for the feeding-plate, a piece of paper or strathmore board should be cut to the exact size of the plate and the center marked by means of two diagonals. The major and minor axes of the forearm should be determined by means of a pair of compasses or calipers. Draw the major and minor axes intersecting the center at right angles to the sides and with two pins attached to a piece of string, the length of the major axis, draw the ellipse. The pins should be placed equidistant from the center, at such a distance that the curve will just intersect the ends of the axes.

The feeding-plate now in use in the cage was bored and cut to fit the pattern of the forearm by a Baltimore firm dealing in plate glass, but it could probably be made more economically by etching with hydrofluoric acid. In this case it could easily be made an exact fit of the forearm of the experimenter. In this case the ellipse could be described as already stated. After taking the axes of the forearm and describing the ellipse, the forearm may be measured with a piece of lead tape, drawn over the ellipse, and the pattern cut out on a piece of paraffined paper. By pouring hydrofluoric acid upon the opening in the paper and using if necessary several pieces of paper, a hole can be etched which will fit accurately the arm from which the pattern was made.

Method of using the feeding-plate.—The feeding-plate may be used, when it is necessary to supply the impregnated females with blood, in the following manner. This involves the substitution of the feeding-plate for the plain glass plate closing the top of the compartment. To do this the screws are removed from the top plate and the feeding-plate placed against its edge and gradually pressed against the top plate until it has replaced the latter, sliding off at the same time the top plate. The opening in the feeding-plate is closed during this manipulation by one of the covers ground to fit the top of the larvae jars. When the feeding-plate is *in situ* and lightly fastened with screws, the cover is removed, and the forearm inserted. If the opening does not fit accurately a piece of gauze is wrapped around the forearm below the elbow. This glass plate allows an uninterrupted view of the females during blood-sucking.

The cost of the cage with the glass plates is about $15. The largest part of the cost is in the glass plates, but the increased facility of observation more than compen-

sates for their cost. These plates cost in Baltimore $1.50 each for the plain plate-glass top plates, and $5 for the feeding-plate. The cost of the latter is mainly in the feeding-opening, as the boring and cutting of these plates is a difficult and delicate operation.

The larvae jars are the cylindrical jars with ground covers used for instruments and dressings, and cost 50 cents each. Their size is 2½″ by 4½″. The wooden foundation may be made by any intelligent carpenter. This portion of the cage cost $2.50. The netting can be applied in half an hour by anyone. An inner layer of fine mesh-cloth netting and an outer layer of wire netting were used in this cage.

The glass feeding-plate will be found especially valuable in removing adult insects from the cage, as it permits binoptric vision, which is very difficult if netting or a gauze sleeve is used. There being no netting in the top of the cage, a full and unobstructed view of the imagines is always available. The combination of the larvae jars with the imago cage relieves the experimenter from any close care and observation other than the maintenance of a proper temperature and the supplying of the imagines with food and blood when necessary.

The larvae jars may be removed from the cage at all times, excepting when the pupae are undergoing metamorphosis. By placing the jars upon a white or neutral surface, nearly all the details of structure necessary for diagnosis may be observed without magnification.

The total weight of the cage, including water in the jars, is less than ten pounds, and it can be easily moved about for observation and demonstration.

With the cage made in three compartments, as in the experiments for which it was devised, two separate methods of treatment and one control were provided for, but any number of compartments can be constructed, or a unit plan may be employed.